Progress Report: GC04-53 (Oct 1, 2006-March 30, 2007)

During this period, a key research focus has been to understand the hydroclimatic underpinnings and the long-term variability of sediment volumes into the Grand Canyon, especially from the Paria River. The importance of identifying the climate-hydrology-sediment linkages is twofold:

1. A foreknowledge of the long-term variability and trends directly impacts the scoping and planning process for Experimental Floods within the context of Beach/Habitat-Building Flows from the Glen Canyon Dam. The planning process is managed through the Grand Canyon Monitoring and Research Center (project co-PI) and uses the sediment load thresholds as a key trigger for experimental design and coordination efforts.
2. Current understanding of the long-term variations in the flood frequency and sediment input is based on Environmental Impacts Studies, wherein limited record of flow and sediment data was used to develop baselines. Based on research results from this project, it has become evident that a joint assessment of the long-term variability in hydrologic and sediment fluxes alongside the climate precursors is a critical step toward providing an assessment of the long-term sediment variability over the 20th century.

The USGS PIs actively participate in the Glen Canyon Dam Adaptive Management Program (GCDAMP) Technical Working Group. The key scientific advisory body for the Adaptive Management Program. To this end, three key research activities were pursued:

1. Analysis of the trends in sediment volumes for the July-October (JASO) season shows no long-term trends in the JASO sediment volumes—substantial interannual variability is evident. However, based on empirical methods developed to estimate the sediment volumes stemming solely from tropical-cyclone (TC) related precipitation and response, an assessment of long-term trends shows substantial attendant variability and a linear trend suggesting a 19% increase in sediment over the past six decades (Figure 1). Ongoing research focuses on a characterization of the interannual and decadal trends in the TC-

related precipitation variability and its spectral coherence with the eastern North Pacific and tropical Pacific sea surface temperatures.

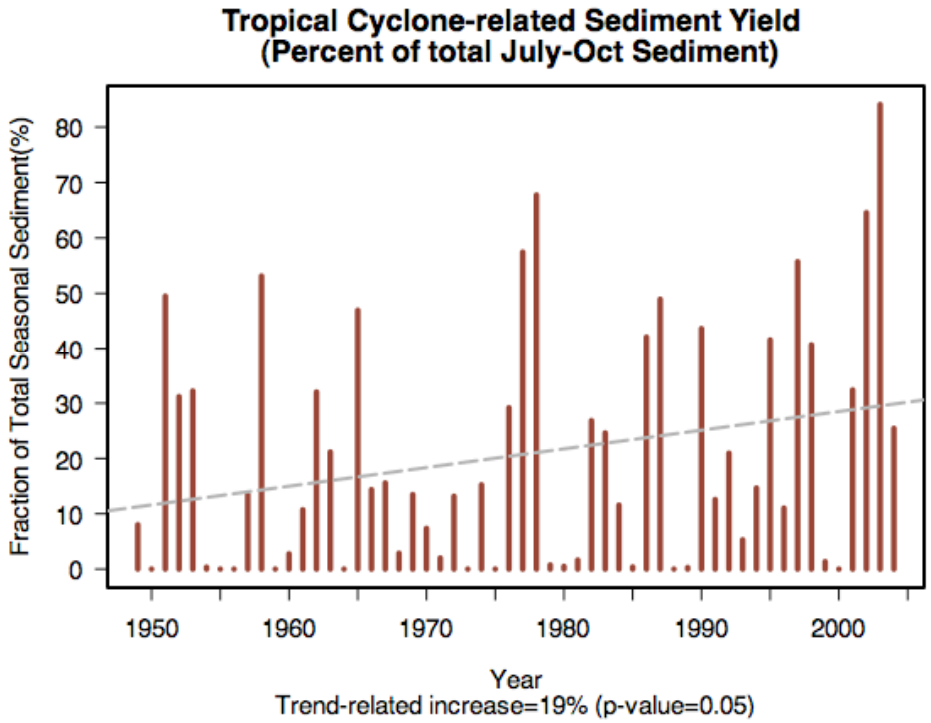

Figure 1. Long-term trends in the fraction of Paria River sediment volume (JASO season) associated with the tropical cyclone-induced precipitation. The empirical methodology to assess the episodic TC impacts uses the post-1948 record of the tropical cyclones in eastern Pacific, and the daily precipitation record for the Grand Canyon region. Separation of seasonal precipitation into two categories: TC-induced and monsoon or warm season precipitation allows a systematic assessment of the climate precursors and drivers modulating the precipitation, floods and sediment production in the Grand Canyon.

2. Reliability of sediment supply from the Paria River was assessed based on a quantification of the temporal changes in the empirical probability distribution of the sediment volumes. Sediment volumes show a high range of variability and are skewed (in a statistical sense). We developed a robust metric to quantify the changes over time, using the notion of the coefficient of variation, however, adapted to handle skewed data and consequently based on robust measures of location and scale of the probability distribution. The results indicate a tendency toward greater variability (decrease in reliability) of sediment supply, especially during the last three decades of the 20th century. This is an important consideration for the decision-making process within the

GCDAMP, and furthermore imply: (a) consideration of temporally varying baselines into the modeling and assessment exercises, and (b) the importance of understanding the long-term relationships and changes between Grand Canyon region hydroclimatology, as it is affected by the North American monsoon, Gulf of Mexico moisture surges, and the eastern North Pacific tropical cyclones.

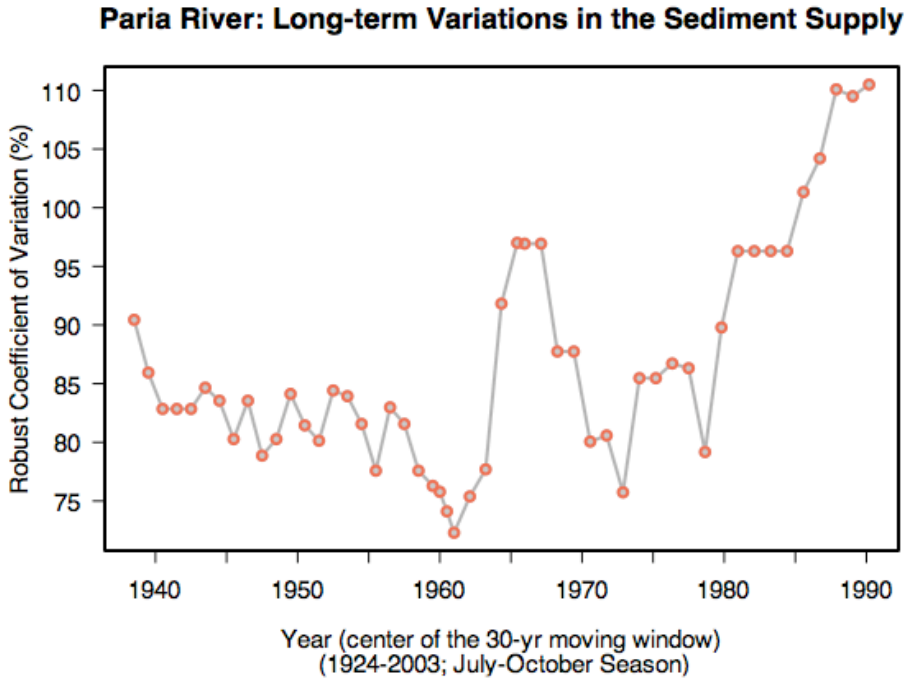

Figure 2. Long-term variations in the reliability of JASO season sediment volumes from Paria River into the Grand Canyon. Robust coefficient of variation (ratio of mean absolute deviation to median) is computed for a 30-year moving window.

2. Understanding the long-term relationships and variability of tropical cyclone-driven floods is critical in developing multiyear coordinated adaptive management efforts within the GCDAMP; the fluctuations in sediment supply and reliable estimates of the TC-precipitation, flood and sediment loads was pursued by reconstructing a record of tropical cyclone episodes back to the early 20th century [based on *Court* (1980)]. Research has focused on using documentary evidence of the tropical cyclones that dissipated in the proximity of the Southwest US. A long chronology of eastern North Pacific cyclones (with dates) has been developed. Current work is focusing on developing sediment load frequency relations, conditional to the tropical cyclone incidence, and also the warm-season

monsoonal precipitation episodes. Preliminary results suggest that conditional sediment load relations have the potential to be used to develop season-ahead outlooks of expected sediment load, a critical information need for GCDAMP BHBF planning efforts.

References

Court, A., "Tropical Cyclone Effects on California." NOAA Tech. Memo. WR-159, 45 pp., National Weather Service, Western Region, Salt Lake City, Utah, 1980.